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(71)(72) Applicant and Inventor: DYBDAHL, Bjørn [NO/NO]; Lillesund Terrasse 4D, N-5500 Haugesund (NO).

(74) Agents: HÅMSØ, Borge et al.; Hamsø Patentbyrå ANS, P.O. Box 171, N-4301 Sandnes (NO).

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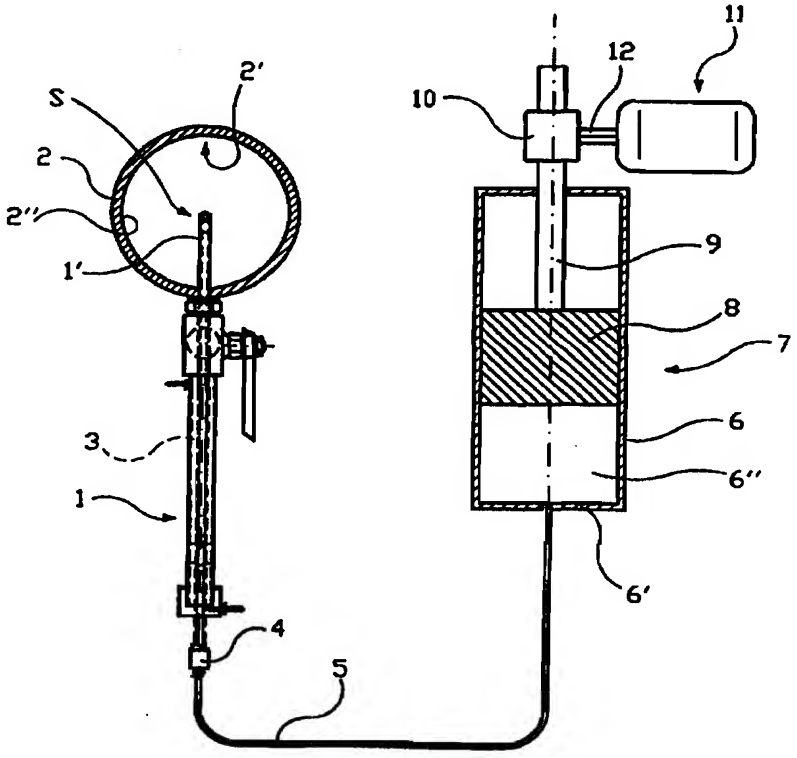
(54) Title: A METHOD IN ISOKINETIC FLUID SAMPLING AND A DEVICE TO BE USED IN CARRYING OUT THE METHOD

(57) Abstract

A fluid sampling apparatus (1) for isokinetic fluid sampling has a probe (1') with at least one orifice which is insertable into and displacable laterally of a pipe (2) in which the fluid flows, and wherein the fluid flowing speed is highest in the centre (S) and lower in the peripheral, annular zone closer to the inner surface (2'') of the pipe wall. The probe (1') can be displaced with variable speed laterally across the flow cross section, its orifice(s) being in fluid communication with a fluid sample accommodating piston cylinder chamber (6'') defined between the inner end piece face of the cylinder (6) and the opposing end face of a piston (8) which is displaced with varying speed while the probe (1') is displaced across the flow cross section, the speed of the piston (8) being highest when the probe (1) is being displaced within the central area of said flow cross section, and lower in the more peripheral areas.



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A METHOD IN ISOKINETIC FLUID SAMPLING AND A DEVICE TO BE USED IN CARRYING OUT THE METHOD

The present invention relates to a method in isokinetic fluid sampling, in which a fluid sampling apparatus having a probe insertable into a defined fluid flow cross-section within a pipe, a pipeline e.g. following downstreamly after a tank, a separator, a heat exchanger or another pipe- or container-like component, takes at least one fluid sample or two fluid samples, respectively, a counterflow-sample and a sample of fluid flowing in the opposite direction, said at least one sample by means of a pipeline/hose or each of said two samples by means of an individual pipeline/hose, respectively, communicating with the fluid samling plant's piston cylinder, the linearly displacable piston's end face, opposite a piston rod, together with the internal end face of the cylinder, define a cylinder chamber in which said fluid sample(s) is/are received.

Likewise, the invention relates to a device in a fluid sampling plant for the same general object, and which is suitable for carrying out the method.

In such isokinetic fluid sampling taking samples of a fluid flowing at elevated speed and temperature, the fluid will often be a two- or multiphase fluid flowing in a pipe or a similar laterally defined, through-going passage or flowing

path, and the two orifices of the probe are circumferentially displaced 180° in respect of each other, so that one orifice sucks in a fluid sample of the fluid flowing in the same direction in which the opening of the orifice is facing, while the other orifice which also sucks in a fluid sample has an opening facing in a direction opposite to the flowing direction of the fluid.

The counterflow fluid sample and the fluid sample taken with the other orifices opening directed in the flowing direction of the fluid are, by means of separate pipelines/hoses, conducted to the measuring apparatus of the fluid sampling plant. Here, the samples are subjected to measurements and analyses not directly related to the present invention. It has been found that separate fluid samplings displaced 180° in said pipe result in a more accurate fluid sampling analysis result than if the probe is equipped with one orifice only. However, the present invention also comprises the use of a fluid sampling apparatus the probe thereof including one orifice only.

The probe is displacable from a socket or a connecting hole in the wall of the pipe at a point on the pipe circumference to a point diametrally opposite.

A fluid mixing apparatus of a well known design is mounted in the pipe etc. upstream in relation to the fluid sampling apparatus. The mixing apparatus comprises sloping flow channels converging in the flowing direction of the fluid to meet in a common central point, the socalled "focal point", in the immediate area for the diametral displacement path of the fluid sampling apparatus probe. The mixing apparatus mixes the two- or multiphase fluid, in order to thusly favour the final fluid sample analysis result. Said central point for maximum fluid mixture will in practice be considered to be lying on the pipe axis.

With such a mixing process where partial flows of fluid are

directed mutually converging toward a common centre, more fluid per cross-sectional area unit per time unit will flow in and close to the axis of the pipe than in the more peripheral portions of the inner pipe cross-section in the area of the diametral displacement path of the probe. At a constant displacement speed, this condition involves that both the counterflow orifice and the other orifice receive a substantially larger amount of fluid from the central area of the fluid flow cross-section than from the more peripheral, annular fluid flowing zones. This makes isokinetic samling impossible and depreciates, thus, to some degree the accuracy of the measuring/analysis results.

From published Norwegian patent application No. 942445, it is known a samling apparatus shaped and designed to take fluid samples isokinetically from a mass flow containing a two- or multiphase fluid flowing in a pipeline assigned calibratable electronic mass flow meters/fraction meters. It is the task of these meters to determine the production amount/share (part) of the various fractions (oil, gas, water/condensate, formation sand, etc.), e.g. percentage per time unit, respectively for delivering a signal for such determination to a computer. The sampling apparatus is connected to the pipeline at a through-going hole for insertion/withdrawal of a probe having at least one orifice and being incorporated in a sampling apparatus as well as being displacable within the fluid flow in the pipeline and to be displaced across substantially the entire internal diameter thereof. Subsequently to concluded sampling, the probe carrying one or two orifices should be withdrawn from the pipeline, the prope insertion/withdrawal hole then being closed by a shut-of valve. Fluid samples taken isokinetically by means of the sampling apparatus are analyzed in order to decide i.a. corresponding fraction values, and said measured values would be usable as reference values as a basis for the possibly necessary calibration of the electronic fraction meters. In cases where the fluid's speed of flow is unevenly distributed across said pipeline's flow cross-section, the larger speed

of flow occurring along the pipeline's centrally extending longitudinal axis, the smaller speed of flow occurring peripherally at the inner wall surface of the pipeline, this known sampling apparatus nor exhibiting the desired degree of accuracy.

It has been proposed (in a Norwegian patent application, not published) to displace the probe using a varying speed across the flow cross-section in the pipe, etc. in such a way that the probe's speed of displacement is higher in the middle zone than in the peripheral, annular zone.

This favours the accuracy of the fluid sampling and results in improved final results after measurements and analysis.

However, the last mentioned measures would still be improvable, and one has aimed at providing such improvements in accordance with the present invention.

To this end, the method according to the invention distinguishes itself through the features as set forth in the characterizing clause of claim 1. A device to be used for carrying out this method, distinguishes itself through the features appearing from the characterizing clause of claim 3.

Thus, the invention enables isokinetic sampling, resulting in optimum accurate measure and analysis values.

A fluid sampling apparatus adapted for isokinetic sampling is shown and described in detail in Norwegian patent specification No. 173,468, and a mixing apparatus of the kind concerned and coupled into a pipeline in which a fluid flows, upstream in respect of said sampling apparatus, is shown and described in detail in Norwegian patent specification No. 174, 015. In Norwegian patent specification No. 176,820, an account is given for a method and an apparatus to be used in connection with isokinetic fluid sampling.

As the present invention has for its object neither detailed features of a fluid sampling apparatus nor detailed features of said mixing apparatus, but, on the contrary, is concerned with measures relating to the fluid sampling which, in per se, presuppose fluid flows in the longitudinal direction of the pipeline which, as measured across the inner pipe cross-section, have uneven flowing speeds, the highest speed of flow occurring along the longitudinal axis of the pipe and in a central zone in the vicinity of said axis, decreasing fluid flow speed occurring in the more peripheral, annular outer zone of the flow cross-section, the mixing apparatus has been deleted on the enclosed drawing figure, the fluid sampling apparatus being shown in a very simplified design only.

This figure illustrates a schematic connection diagram for a fluid sampling apparatus connected to a piston cylinder. The connection diagram constitutes an examplary embodiment that can vary within the scope of the apparatus claim (3).

In the figure, reference numeral 1 denotes an apparatus for isokinetic fluid sampling of a two- or multiphase fluid which, in the examplary embodiment, flows within a pipe 2 having a lateral hole through the pipe wall for a probe 1' belonging to the sampling apparatus 1. In the examplary embodiment it is, for simplifying purposes, assumed that the probe 1' at the end thereof is equipped with one orifice only. In the pipe 2, at a certain distance upstream of the diametral displacement path of the probe 1', as measured along the longitudinal direction of the pipe 2, a mixing apparatus (not shown) is disposed. This mixing apparatus which is shown and described in detail in Norwegian patent specification No. 174, 015, has inclined channels converging in the flowing direction and guide fluid part streams to meet in a common centre, in or in the immediate neighbourhood of that cross-sectional plane along which the probe 1' with its one or two orifices is displaced diametrally within the pipe 2. As previously mentioned, the fluid flow concentrates in the

area of the pipe axis S, so that a larger amount of fluid passes centrally within the pipe 2 in the pipe cross-section wherein the probe 1' is displaced, than in the periphery, annular zone at a larger radial distance from said centre S.

In order to compensate for this concentrated, unevenly distributed fluid flow across the pipe's cross-section, so that the conditions can be ordered for isokinetic sampling also in connection with fluid exhibiting mutually differing speed of flow as measured across the cross-section of the pipe, it has been proposed to displace the probe 1' so that its speed is varied along the diametral displacement path within the pipe 2, so that the displacement speed is higher in and at said centre and lower in the peripheral, annular zone. With the probe tip in a starting position aligned with the pipe's inner wall surface 2" at the insertion/passage hole, the probe's displacement is accelerated until the probe tip with its one or two orifices is in the act of passing said centre, whereafter the displacement is retarded until the probe tip has arrived at the diametrally opposite point 2' at the inner surface 2" of the pipe wall.

In the examplary embodiment according to the figure, it is assumed that the fluid sampling apparatus 1 takes fluid samples isokinetically from a flowing two- or multiphase fluid flowing in the pipe 2. The fluid sample passes through a longitudinal channel 3 within the fluid sampling apparatus 1, conducting said fluid to a connector 4 connected to a pipeline/hose 5 leading through the cylinder bottom 6' of a cylinder 6 incorporated into a piston cylinder 7, the piston 8 thereof, axially displacable up and down, carrying a coaxial upright piston rod 9.

The piston rod 9 of the piston cylinder 7 is shaped as a gearing means in the form of a rack or a threaded spindle meshing with a drive pinion or a threaded drive means surrrounded by a ring 10 and driven by a rotary motor 11 through the outgoing shaft 12 thereof. Activation of the

rotary motor 11 (which may have reversible rotational direction), e.g. so that the piston 8 is caused to displace itself upwardly within the cylinder 6, space is provided in the increasing cylinder chamber 6" for the amount of fluid flowing into the same at any time. Said amount of fluid may vary per time unit dependent on where within the cross-section of the pipe the sample fluid comes from. In practice, one will displace the piston 8 using a higher speed when the orifice(s) of the probe is/are located in the central area of the pipe cross-section, in order to take care of the relatively larger amount of fluid from this area, than when the orifice(s) of the probe is/are located within the more peripheral areas where the amount of fluid flowing into the chamber 6" per time unit is less and where, thus, the cylinder chamber 6" does not have to take care of the same large amounts of fluid per time unit due to the relatively lower speed of flow in the non-central area. These measures secure ideal conditions for isokinetic sampling.

Additionally, the probe can be displaced using variable speed along the lineary movement path thereof such as defined previously. These measures give in combination an optimum exact fluid sample and the measuring/analysis result thereof will exhibit a very high degree of accuracy.

It should be noted that the separate components in the figure of the drawing are not drawn on the same scale.

The present invention aims at favouring the fluid sampling through the orifice of the probe, more specifically by allowing isokinetic sampling to take place in spite of uneven fluid flow speed/concentration as measured across the fluid flow cross-section of the pipe.

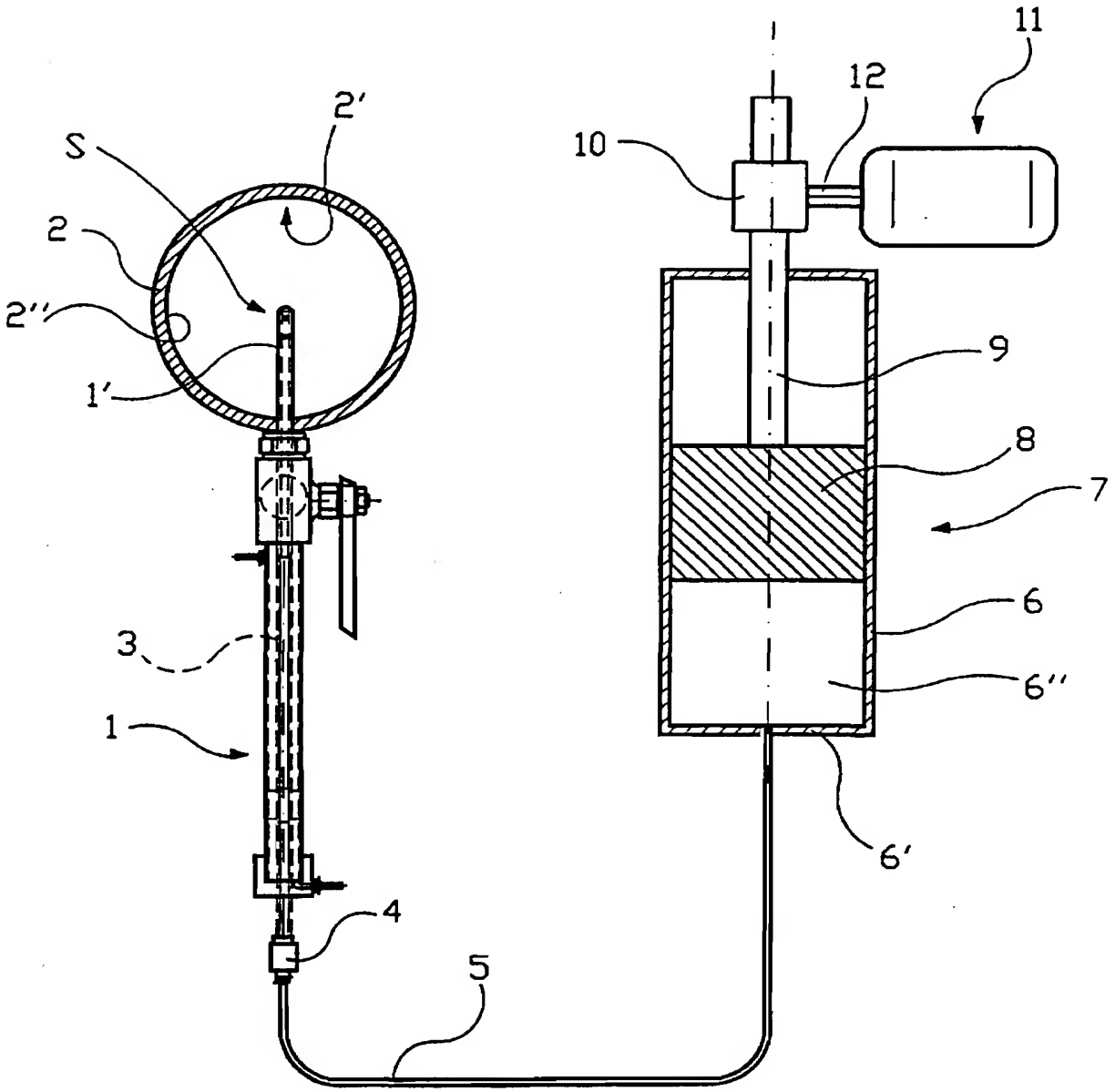
C l a i m s

1. A method in or relating to fluid sampling, wherein a probe (1') having one or two oppositely facing orifice(s) and comprised by a fluid sampling apparatus is displaced laterally within a pipe (2) or other pipe- or container-like, laterally defined, through-going passage, in which the fluid flows, and wherein the probe (1') is displaced diametrally laterally across the flow cross-section defined by the inner surface of the pipe wall, and wherein the orifice(s) of the probe (1') is/are in fluid communication with a fluid sample accommodating piston cylinder (7) having a piston (8) displacably disposed within the cylinder (6), c h a r a c - t e r i z e d i n that the piston (8) - in order to make the conditions right for isokinetic sampling - is caused to displace itself with varying speed while the probe (1') with the orifice(s) is displaced across the cross-section of said passage, the flow cross-section, from a substantially peripheral point, through a substantially centrally located point (S) to a substantially diametrally located, essentially peripheral point (2').

2. A method as set forth in claim 1, c h a r a c - t e r i z e d i n that the speed of said piston (8) is varied such that the speed is highest when the probe tip with the orifice(s) passes the centre (S) in the flow cross-section in which the probe (1') is displacable, and lower in the peripheral, annular zone of the flow cross-section.

3. A device for use in carrying out the method as set forth in claim 1 or 2 in connection with isokinetic fluid sampling, comprising a fluid sampling apparatus (1) having a probe (1') equipped with at least one orifice and insertable/displacable in a laterally defined, through-going passage, such as a pipe (2), in which a fluid flows, laterally of the flowing direction along a displacement path extending at least approximately diametrally, and wherein said at least one

orifice at the tip of the probe (1') is subjected to a suction pressure in order to cause fluid to be sucked into said at least one orifice, and wherein the probe's (1') one orifice or each of its two orifices, respectively, communicates with or can be brought to communicate with, respectively, a cylinder chamber (6") incorporated in a piston cylinder (7) comprising a displacable piston (8), c h a r a c t e r i z e d i n that the piston (8) of said piston cylinder (7) is disposed such that a drive means (11) can give it a displacement movement in the cylinder (6) varying in speed while the probe (1') with its orifice(s) is displaced laterally across the flow cross-section of said passage (2).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INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 97/00250

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G01N 1/20
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9600837 A1 (DYBDAHL, BJÖRN), 11 January 1996 (11.01.96), page 6, line 31 - page 7, line 19	1-3

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9600837 A1	11/01/96	AU 2899595 A	25/01/96
		EP 0764236 A	26/03/97
		NO 942445 A	02/01/96